Regulatory Fit and Cognitive Assessment

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Outline

• Motivation and cognition - Regulatory Focus Theory
  ➢ Regulatory Fit vs. Mismatch
  ➢ Some findings

• Possible neuropsychological implications

• Gold standard test of executive function
  (Wisconsin Card Sorting Task)

• Results: Motivational “impairment” in normal population

• Future directions
Regulatory Focus Theory

• Goals
  ➢ Goals or manner for completing goals can be non-consciously adopted or effected
  ➢ Approach goals vs. Avoidance goals

• State of readiness for goal type
  ➢ Promotion focus (for Approach goals)
  ➢ Prevention focus (for Avoidance goals)

• Sensitivity to environment structure
  ➢ Potential gains (when in Promotion focus)
  ➢ Potential losses (when in Prevention focus)

• Reliable cognitive consequences when Focus and Structure *match*

Markman, Maddox & Baldwin, 2005
Higgins et al. 2003
Regulatory Focus Theory

Basic cognitive processing influenced by interaction of:

Current regulatory focus
Promotion Prevention

Local reward structure of the task
Gains Losses
Regulatory Focus Theory

Basic cognitive processing influenced by interaction of:

**Current regulatory focus**

<table>
<thead>
<tr>
<th>Promotion</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>START STATE</strong></td>
<td><strong>GOAL</strong></td>
</tr>
<tr>
<td>0</td>
<td>approach</td>
</tr>
</tbody>
</table>

**Local reward structure of the task**

<table>
<thead>
<tr>
<th>Gains</th>
<th>Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑ 0%</td>
<td>100% ↓</td>
</tr>
</tbody>
</table>
Regulatory Focus Theory

Basic cognitive processing influenced by interaction of:

<table>
<thead>
<tr>
<th>Local reward structure of the task</th>
<th>Promotion</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Gains</td>
<td>FIT</td>
<td>mismatch</td>
</tr>
<tr>
<td>Losses</td>
<td>mismatch</td>
<td>FIT</td>
</tr>
</tbody>
</table>
Regulatory Focus Theory

Basic cognitive processing influenced by interaction of:

Current regulatory focus

Usually implicit

Promotion

Prevention

Local reward structure of the task

Gains

FIT

mismatch

Losses

mismatch

FIT
Being in a Regulatory Fit

• Flexibility in classification learning

• Bias shifts in response to reward & sensitivity boosts in signal detection tasks

• Overcoming local reward minima in decision making task

• Increased exploration in an $n$-armed bandit task (whether optimal or not)

• Stereotype threat
  • Chronic stereotypes interact with reward structure
  • Gender and GRE math test
  • Primed stereotypes and rule based classification

• Beginning vs. End of semester

Markman, Maddox & Baldwin, 2005
Worthy, Maddox & Markman, 2007
Grimm, Markman, Maddox & Baldwin, 2008
Various manuscripts under review or in preparation
Possible Clinical Links

• **Possible chronic regulatory focus component**
  - Chronic avoidance in depression (Pizzagalli, Jahn & O’Shea, 2005; Taylor Tavares, et al., 2008)
  - Cognitive flexibility in OCD and trichotillomania (Chamberlain et al., 2006)

• **EF diagnosis may depend on regulatory fit**
  - Insensitivity to task with gains reward structure in first-episode psychosis (Murray et al., 2008)
  - Executive functioning impairments in traumatic brain injury and disease (Demakis, 2003)
Clinical Tests of Executive Functioning

- Tower of London test

- Trail-Making Test

- Stop signal task

- Wisconsin Card Sorting Task
  - Broad appeal
  - Popular assessment and research tool
  - Clinicians compare individuals to norms
  - Part of batteries used diagnose people
  - Flexibility is optimal for this task
Wisconsin Card Sorting Task

- Clinicians use WCST as part of a battery
- Diagnoses made, lives changed based on performance
- No control for motivational state of the client
Wisconsin Card Sorting Task

- Sort cards along three dimensions
- Relevant dimension changes after 10 correct responses (rule change)

- Thus, executive functioning impairments lead to perseverating on an irrelevant rule
Correct: Rule = Shape
Incorrect: Rule = Color

WCST Dependent Variables
- Trials to reach 1\textsuperscript{st} rule
- Trials to reach 2\textsuperscript{nd} rule
- Perseveration Rate
Clinical Example

- Traumatic brain injury (TBI)
  - Perseverative errors on WCST-128 used as cutoff for Normal vs. Impaired
  - +/- a few responses could change Dx
  - What if motivational environment was different?

Sherer et al., 2003

One datapoint
**WCST + Motivation**

- Incorporate Regulatory Focus framework

<table>
<thead>
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<tr>
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<td>mismatch</td>
<td>FIT</td>
</tr>
</tbody>
</table>

Correct, you gained 3 points
WCST + Motivation

Regulatory Focus

Promotion

<table>
<thead>
<tr>
<th>START STATE</th>
<th>GOAL</th>
<th>FUTURE STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>approach</td>
<td>SPECIAL PRIZE</td>
</tr>
</tbody>
</table>

Prevention

<table>
<thead>
<tr>
<th>START STATE</th>
<th>GOAL</th>
<th>FUTURE STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>avoid</td>
<td>SPECIAL PRIZE</td>
</tr>
</tbody>
</table>

Reward Structure

Gains

| +3 |

Losses

| -1 |
Wisconsin Card Sorting Task

- Situational focus

<table>
<thead>
<tr>
<th>Promotion</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARN raffle ticket</td>
<td>KEEP raffle ticket</td>
</tr>
</tbody>
</table>

- Reward structure of the task

<table>
<thead>
<tr>
<th>Gains</th>
<th>Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>+3 correct</td>
<td>-1 correct</td>
</tr>
<tr>
<td>+1 wrong</td>
<td>-3 wrong</td>
</tr>
</tbody>
</table>
### Wisconsin Card Sorting Task

<table>
<thead>
<tr>
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<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FIT</td>
<td>mismatch</td>
</tr>
<tr>
<td><strong>FIT</strong></td>
<td><img src="image1" alt="Card Sort" /></td>
<td><img src="image2" alt="Card Sort" /></td>
</tr>
<tr>
<td><img src="image3" alt="Message" /></td>
<td>Correct, you gained 3 points</td>
<td><img src="image4" alt="Message" /></td>
</tr>
<tr>
<td><strong>mismatch</strong></td>
<td><img src="image5" alt="Card Sort" /></td>
<td><img src="image6" alt="Card Sort" /></td>
</tr>
<tr>
<td><img src="image7" alt="Message" /></td>
<td><img src="image8" alt="Message" /></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Losses</th>
<th>Promotion</th>
<th>Prevention</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>mismatch</td>
<td>FIT</td>
</tr>
<tr>
<td><strong>mismatch</strong></td>
<td><img src="image9" alt="Card Sort" /></td>
<td><img src="image10" alt="Card Sort" /></td>
</tr>
<tr>
<td><img src="image11" alt="Message" /></td>
<td>Correct, you lost 1 point</td>
<td><img src="image12" alt="Message" /></td>
</tr>
<tr>
<td><strong>FIT</strong></td>
<td><img src="image13" alt="Card Sort" /></td>
<td><img src="image14" alt="Card Sort" /></td>
</tr>
<tr>
<td><img src="image15" alt="Message" /></td>
<td><img src="image16" alt="Message" /></td>
<td></td>
</tr>
</tbody>
</table>
Trials to Learn 1st Rule

Trials to Learn 2nd Rule

Perseveration Rate
Regulatory Focus and WCST

Only high functioning individuals that were able to complete the task were used for analysis

**Regulatory fit**
- Learn first and second rule faster
- Less perseverative errors

**Regulatory mismatch**
- Slower learning
- More perseverative errors

![Regulatory Focus and WCST Diagram](attachment:image.png)
Clinical Example (reiterated)

- Traumatic brain injury (TBI)

  - Perseverative errors on WCST-128 used as cutoff for Normal vs. Impaired

  - +/- a few responses could change Dx

  - What if motivational environment was different?

Sherer et al., 2003
Impairment Analysis

• Control group used to create a normative sample
  ✓ No situational focus manipulation
  ✓ No point-based reward structure

• Classify individuals as “impaired”
  ✓ 1.1 SD from control mean considered impaired
  ✓ Typical for clinical assessment
Impairment Analysis

- Control group used to create a normative sample
- 1.1 SD from control mean considered impaired
- Typical procedure that used in psychiatric nosology

- This is a high functioning population
Implications for Assessment

• Poor WCST performance
  ✓ May partly reflect differences in regulatory fit
  ✓ WCST usually in gain/undetermined reward environment

• Assessment
  ✓ Some neuropsychiatric disorders may have components that are influenced by regulatory focus
    • Chronic avoidance in Depression
    • Cognitive flexibility in OCD and trichotillomania
  ✓ Idea: Manipulate reward structure (Gains vs. Losses)
Implications for Treatment

• Environment modification
  ✓ Modify home or learning environment to counteract or cater to chronic focus

  ✓ Example: Emphasize loss minimization to foster a regulatory fit with chronic prevention focus

• Social neuroscience and treatment
  ✓ Evidence that rewards/punishments mediated by different neural systems

  ✓ So, possible that $FIT_{\text{Promotion-Gains}}$ and $FIT_{\text{Prevention-Losses}}$ mediated by different neural circuits

✓ Switch regulatory focus style to emphasize a normal neural pathway over a damaged one
Conclusion

• Regulatory focus theory (Regulatory fit vs. mismatch)

• Proof of Concept
  • *Normal high functioning population!*
  • WCST performance depending on motivation state
  • Up to 25% of those in regulatory mismatch conditions may be considered “impaired”

• Some neuropsychiatric disorders may have motivational component

• Some diagnoses could depend on motivational state
Future Directions

• Social neuroscience
  ✓ Possible that although same behavior within fit and mismatch conditions, they are mediate by different neural circuits
  ✓ Modified version for fMRI investigation

• Test clinical populations (underway at UCSD)
  ✓ Depression
  ✓ Eating disorders
  ✓ Parkinson’s disease

➢ Use reward structure manipulation (Gains vs. Losses) to look for chronic regulatory focus component
Thanks to the Motivation Group & MaddoxLab

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